

Mlake – a hotspot of butterfly diversity in Slovenia

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Abstract. The Mlake military area in Vipava Valley has been recognized as possibly the most prominent 'hot spot' of butterfly diversity in Slovenia. An area of less than one square kilometre hosts 102 butterfly species or almost 57% of the total species confirmed for Slovenia. Among these, 23 species have been recognized as nationally or continentally threatened. Due to recent urbanization, the total area suitable for butterflies has been reduced to less than half, however, the effects on butterfly diversity of the area are not yet visible. The loss of several habitat specialist butterfly species and declines visible from transect monitoring in the last five years do, however, indicate the ongoing process of habitat degradation in Mlake military area. A focused management of the remaining habitats will be required to reverse this process.

Key words: biodiversity, military area, threatened species, nature conservation, Lepidoptera

Izvleček. MLAKE – VROČA TOČKA VRSTNE PESTROSTI DNEVNIH METULJEV V SLOVENIJI – Vojaško območje Mlake v Vipavski dolini je verjetno ena izmed najbolj 'vročih točk' pestrosti dnevnih metuljev v Sloveniji. Na območju, manjšem od enega kvadratnega kilometra, sta bili namreč najdeni kar 102 vrsti dnevnih metuljev, ali skoraj 57 % vseh za Slovenijo potrjenih vrst. Med njimi je tudi 23 vrst s statusom ogroženosti bodisi na nivoju Slovenije ali Evrope. Zaradi nedavnih gradbenih posegov se je območje ustreznih habitatov za dnevnih metuljev skrčilo za več kot polovico, vendar učinek tega neposredno na pestrost vrst vsaj za zdaj še ni opazen. O degradaciji habitatov pričata izguba nekaterih specializiranih vrst dnevnih metuljev v zadnjem obdobju in zmanjševanje pestrosti in številčnosti metuljev na transektu v zadnjih petih letih. Nadaljnji degradaciji bi se lahko izognili le z načrtnim upravljanjem še ohranjenih habitatov.

Ključne besede: biodiverzitet, vojaško območje, ogrožene vrste, varstvo narave, Lepidoptera

Introduction

The Vipava Valley has long been known as one of the butterfly richest regions in Slovenia. It was also the first region of the current Slovenian territory surveyed, with Josef Mann publishing the list of species as early as in the mid-19th century (Mann 1854). He recorded 78 butterfly species for the Vipava Valley, mainly in the surrounding of Vipava town. The next important publication was published by Ivan Hafner who visited the valley regularly when producing the first comprehensive list of Macrolepidoptera of Kranjska (Hafner 1909 – 1912). In addition, he published a separate faunistic report for the lower Vipava Valley, the surrounding of Gorica, where he recorded 106 butterfly species. After that, not much was published about distribution of butterflies in this region, apart from the report from the Biology Student Research Camp in Sempas 1998 (Verovnik 2000). This report includes the first records for the Mlake military area, which was already recognized for its great potential of exceptionally high butterfly diversity. In two visits at the end of July, 40 species were observed within the military area.

Due to military activities by the Yugoslav Army, the area was off limits for most of the time after the Second World War. That has helped saving the humid grasslands that have been drained with extensive hydro-meliorations elsewhere in the Vipava Valley (Urbanc & Perko 2002). Due to regular military activities, this merely one square kilometre large area was exceptionally diverse in terms of habitat and structure. It included dry calcareous grasslands on the slopes, wet grasslands on the flatter part of the area and several man-made hills and ditches with sparse vegetation coverage. Unfortunately, soon after the discovery of its high conservation value, the area was doomed to be overrun by a highway and rearranged into a modern military shooting facility. Even inclusion of the site into the NATURA 2000 network (Uradni list RS, no. 49/2004) did not help, as building permits had already been approved. Thus the construction of the highway started in 2002, followed by the building of a modern shooting range in 2005. Due to various NGO activities, the route of the highway was moved to the edge of the Mlake military area, thus only partially affecting the humid part of the site (Fig. 1).

In order to compare how these changes have affected the butterfly fauna of the Mlake military area, the results of faunistic surveys carried out in the 1998-2002 period are compared to the 2007-2011 period. During the first period, the site was visited on several occasions, also as organized field trips for biology students of the Biotechnical Faculty, providing a good overview of the butterfly fauna. During building activities, the area was not visited regularly and the surveys continued from 2007 onwards, when transects for long term monitoring of butterflies in Slovenia were set in the remaining part of the Mlake military area as part of a wider evaluation of the military areas in Slovenia (Tome et al. 2008). As intensive surveys were carried out in both periods, the comparison of the butterfly fauna composition is possible, despite different approaches. Our main aims are: 1 – to evaluate the changes in butterfly fauna composition; 2 – to advocate great butterfly diversity and importance of the Mlake military area; and 3 – to show how current changes have negatively affected the abundance of the butterflies in this area.



Figure 1. Mlake military area from the slopes of Mt. Nanos before (above) and after (below) the highway and shooting range construction. (photo: Peter Valič)

Slika 1. Vojaško območje Mlake, fotografirano s pobočja Nanosa pred (zgoraj) in po (spodaj) gradbenih posegih. (foto: Peter Valič)

Materials and methods

The Mlake military area is approximately 97 hectares of land wedged between the foothills of Mt. Nanos and the Podnanos - Vipava main road (Fig. 1). Due to highway and shooting facility construction, the size of the suitable area for butterflies has shrunk to approximately 45 ha (Fig. 2). This has also led to the abandonment of grasslands on the slopes above the shooting range, which are now subject to rapid overgrowing.



Figure 2. Aerial photograph of the Mlake military area in the past (left) and present (right). The boundaries show approximate extent of habitat important for butterflies. The position of the transect with 5 sections is given on the right map.

Slika 2. Zračni posnetek vojaškega območja Mlake v preteklosti (levo) in danes (desno). Meje prikazujejo območje življenjskega prostora, pomembnega za dnevne metulje. Postavitev petih odsekov transektja je prikazana na recentni karti.

During the first period (1998 – 2002), altogether 26 surveys were carried out. Butterfly net was used for netting butterflies, which were released after determination. The Tolman & Lewington (1997) field guide was used for determination. In the second period (2007 – 2011), transect with 5 sections in total length of 1320 m was established (Fig. 2) in the remaining part of the open grassland habitat. Transect was walked 6 to 8 times during the season (end of April – August) following the standard transect protocol (Pollard & Yates 1993). Comparing to the first period, the survey effort was greater with 43 visits, and qualitative data on species relative abundances were gathered. In order to exclude the effect of different sampling effort between years, the relative abundances of butterflies on the transect were calculated according to the following formula:

$$RA = (\text{No. of specimens} \times 1000) / (\text{length of transect} \times \text{number of visits})$$

Results

In all years pooled together, 102 butterfly species or approximately 57% of all butterflies confirmed for Slovenia were found at the site (Tab. 1). Among these, seven species were found only in the first time period and 10 species only in the second period. High nature value of the surveyed area is underlined by the presence of 23 species listed in the Red Data Book of Slovenia (Uradni list RS, no. 82/2002). Among these, five are also included in annexes of the Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora).

Table 1. The list of butterfly species observed in the Mlake military area. Records of species are given for the two time periods. The threat status in Slovenia (SLO) according to the Red Data Book (Uradni list RS, no. 82/2002) and the inclusion into the annexes of the Habitats Directive (FFH) are indicated (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). The taxonomy and nomenclature follow van Swaay et al. (2010).

Tabela 1. Seznam dnevnih metuljev, opaženih na vojaškem območju Mlake v dveh časovnih obdobjih. Podana sta status ogroženosti vrst v Sloveniji (SLO) po Rdečem seznamu (Uradni list RS, št. 82/2002) in vključenost vrst v Direktivo o habitatih (FFH) (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). Poimenovanje in razvrstitev metuljev sta povzeta po van Swaay et al. (2010).

Species	1998 – 2002	2007 – 2011	SLO	FFH
Hesperiidae				
<i>Pyrgus malvae</i>	•	•		
<i>Pyrgus malvoides</i>	•	•		
<i>Pyrgus alveus</i>		•	V	
<i>Pyrgus armoricanus</i>	•	•	V	
<i>Spialia sertorius</i>	•	•	V	
<i>Carcharodus alceae</i>	•	•	V	
<i>Carcharodus flocciferus</i>	•	•	E	
<i>Carcharodus lavatherae</i>	•		E	
<i>Erynnis tages</i>	•	•		
<i>Carterocephalus palaemon</i>		•		
<i>Heteropterus morpheus</i>	•	•		
<i>Thymelicus lineola</i>	•	•		
<i>Thymelicus sylvestris</i>	•	•		
<i>Hesperia comma</i>	•	•		
<i>Ochlodes sylvanus</i>	•	•		
Papilionidae				
<i>Papilio machaon</i>	•	•		
<i>Iphiclides podalirius</i>	•	•		
<i>Zerynthia polyxena</i>	•	•	V	IV
Pieridae				
<i>Aporia crataegi</i>	•	•		
<i>Pieris brassicae</i>	•	•		
<i>Pieris rapae</i>	•	•		
<i>Pieris mannii</i>	•	•	V	
<i>Pieris ergane</i>	•		V	
<i>Pieris napi</i>	•	•		
<i>Antiocharis cardamines</i>	•	•		
<i>Pontia edusa</i>	•	•		
<i>Colias croceus</i>	•	•		
<i>Colias alfacariensis</i>	•	•		

Species	1998 – 2002	2007 – 2011	SLO	FFH
<i>Gonepteryx rhamni</i>	•	•		
<i>Leptidea sinapis/reali</i>	•	•		
Lycaenidae				
<i>Callophrys rubi</i>	•	•		
<i>Satyrus acaciae</i>	•	•		
<i>Satyrus ilicis</i>	•	•		
<i>Satyrus spini</i>	•	•		
<i>Satyrus w-album</i>		•		
<i>Favonius quercus</i>		•		
<i>Lycaena phlaeas</i>	•	•		
<i>Lycaena dispar</i>	•	•	V	II, IV
<i>Lycaena tityrus</i>	•	•		
<i>Lycaena alciphron</i>	•	•	V	
<i>Leptotes pirithous</i>	•	•		
<i>Cupido alcetas</i>	•	•		
<i>Cupido argiades</i>	•	•		
<i>Cupido minimus</i>	•	•		
<i>Celastrina argiolus</i>	•	•		
<i>Pseudophilotes vicrama</i>	•	•	V	
<i>Scolitantides orion</i>	•		V	
<i>Glaucopsyche alexis</i>	•	•		
<i>Phengaris teleius</i>	•	•	V	II, IV
<i>Phengaris alcon</i>	•	•	E	
<i>Plebejus argyrognomon</i>	•	•	V	
<i>Plebejus argus</i>	•	•		
<i>Plebejus idas</i>	•		V	
<i>Aricia agestis</i>	•	•		
<i>Cyaniris semiargus</i>	•	•		
<i>Polyommatus amandus</i>	•			
<i>Polyommatus dorylas</i>		•		
<i>Polyommatus icarus</i>	•	•		
<i>Polyommatus bellargus</i>	•	•		
<i>Polyommatus daphnis</i>	•	•	V	
Riodinidae				
<i>Hamearis lucina</i>	•	•		
Nymphalidae				
<i>Libythea celtis</i>		•		
<i>Apatura ilia</i>	•	•	V	
<i>Limenitis reducta</i>	•	•		
<i>Limenitis camilla</i>	•	•		
<i>Nymphalis polychloros</i>	•	•		
<i>Aglais io</i>	•	•		
<i>Aglais urticae</i>	•	•		
<i>Vanessa atalanta</i>	•	•		
<i>Vanessa cardui</i>	•	•		
<i>Polygonia c-album</i>	•			
<i>Argynnis paphia</i>	•	•		
<i>Argynnis adippe</i>	•	•		
<i>Argynnis niobe</i>	•	•		
<i>Issoria lathonia</i>	•	•		
<i>Brenthis daphne</i>	•	•		
<i>Brenthis hecate</i>	•	•		

Species	1998 – 2002	2007 – 2011	SLO	FFH
<i>Brenthis ino</i>	•	•		
<i>Boloria dia</i>	•	•		
<i>Melitaea phoebe</i>	•	•		
<i>Melitaea cinxia</i>	•	•		
<i>Melitaea didyma</i>	•	•		
<i>Melitaea diamina</i>	•	•	V	
<i>Melitaea britomartis</i>	•		V	
<i>Melitaea aurelia</i>	•	•	V	
<i>Melitaea athalia</i>	•	•		
<i>Euphydryas aurinia</i>	•	•	V	II, IV
<i>Melanargia galathea</i>	•	•		
<i>Hipparchia fagi</i>	•	•		
<i>Arethusana arethusa</i>	•	•		
<i>Minois dryas</i>	•	•		
<i>Brintesia circe</i>	•	•		
<i>Erebia aethiops</i>		•		
<i>Erebia medusa</i>		•		
<i>Maniola jurtina</i>	•	•		
<i>Pyronia tithonus</i>	•	•		
<i>Lopinga achine</i>		•		IV
<i>Coenonympha pamphilus</i>	•	•		
<i>Coenonympha arcania</i>	•	•		
<i>Pararge aegeria</i>	•	•		
<i>Lasiommata maera</i>	•	•		
<i>Lasiommata megera</i>	•	•		

The number of newly recorded species (Fig. 3) shows a typical pattern of saturation with most species being recorded already in the first two years. The large number of newly discovered species in the second year (1999) is related to a late start in 1998 with the first visit to the site at the beginning of July. Thus, many spring species were not covered by the surveys in 1998. A moderate increase of newly found species in the 2007-2009 period could be related to the new survey technique, the transect walks. These are more regularly spread over the entire flight season and provide a greater chance of finding rare species.

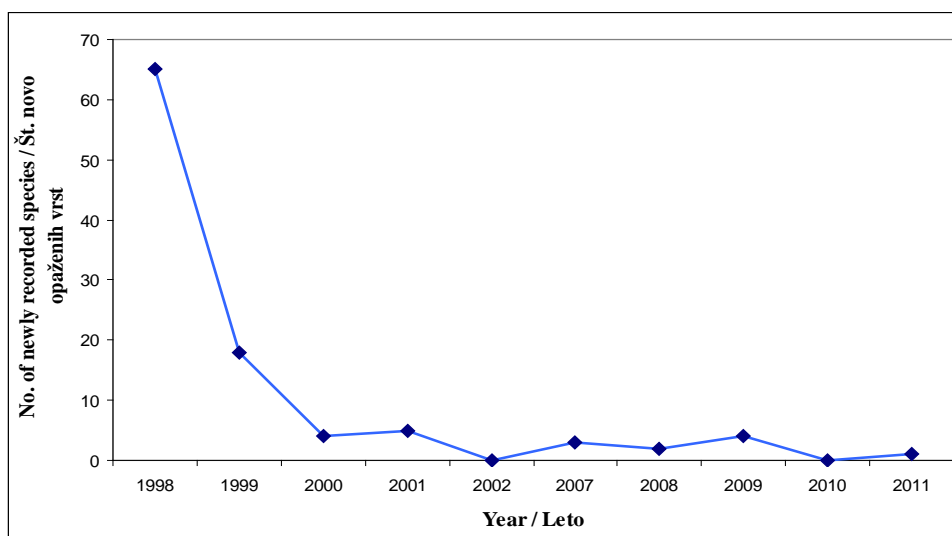


Figure 3. The number of newly recorded butterfly species in the Mlake military area in the 1998-2011 period.

Slika 3. Letno število na novo opaženih vrst dnevnih metuljev v vojaškem območju Mlake med letoma 1998 in 2011.

No data on abundances are available for the first period, therefore the comparison with recent transect data in that aspect is not possible. However, even in the last five years a negative trend both in terms of species diversity (Fig. 4) and relative abundances (Fig. 5) on the transect were observed. The number of species discovered and abundances depend on climatic conditions during the season, however, these can be related only to minimal fluctuations in the last four years, but not to the decline between the 2007 and 2008 seasons.

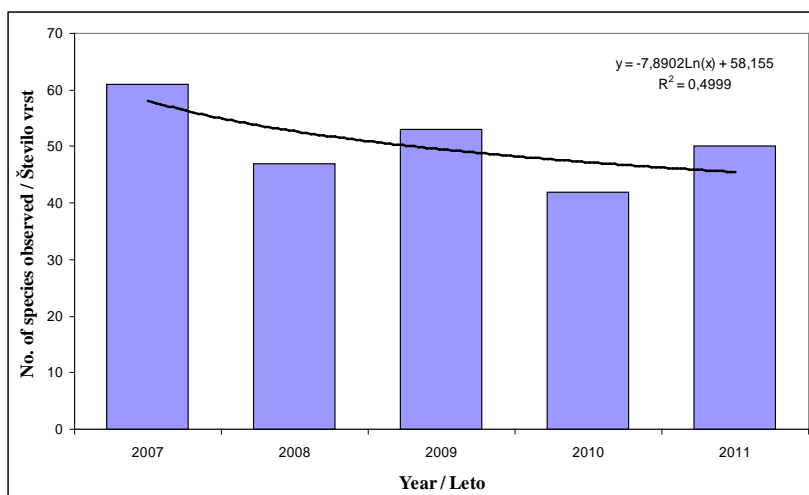


Figure 4. Number of butterfly species observed each survey year in the Mlake military area. The trendline shows a moderate diversity decline.

Slika 4. Letno število vrst dnevnih metuljev, opaženih v vojaškem območju Mlake. Trendna črta kaže zmeren upad števila vrst.

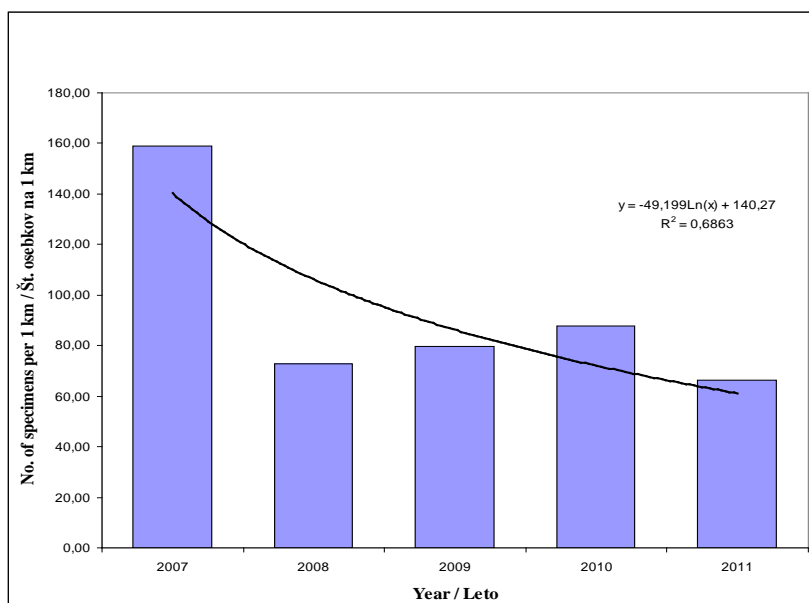


Figure 5. Relative abundances of butterflies recorded each survey year (see Methods for explanation) in the Mlake military area. The trendline shows a moderate decline in the number of specimens.

Slika 5. Relativne letne abundance dnevnih metuljev (glej Metode za pojasnilo) v vojaškem območju Mlake. Trendna črta kaže zmeren upad številčnosti opaženih osebkov.

Table 2. List of the 25 most common species observed on the Mlake transect during the 2007-2011 period and the number of specimens observed. The threatened species in Slovenia (Uradni list RS, no. 82/2002) are marked with bold font.

Tabela 2. Seznam 25 najpogostejših vrst, opaženih na transektu na vojaškem poligonu Mlake med letoma 2007 in 2011 in skupno število opaženih osebkov. Ogrožene vrste v Sloveniji (Uradni list RS, no. 82/2002) so označene z krepkim tiskom.

Species	No. of specimens
<i>Melanargia galathea</i>	962
<i>Maniola jurtina</i>	826
<i>Coenonympha pamphilus</i>	586
<i>Leptidea sinapis/reali</i>	160
<i>Coenonympha arcania</i>	143
<i>Melitaea didyma</i>	96
<i>Boloria dia</i>	82
<i>Ochlodes sylvanus</i>	77
<i>Vanessa cardui</i>	77
<i>Melitaea aurelia</i>	75
<i>Euphydryas aurinia</i>	72
<i>Phengaris teleius</i>	68
<i>Melitaea athalia</i>	68
<i>Melitaea phoebe</i>	60
<i>Brenthis hecate</i>	59
<i>Arethusana arethusa</i>	54
<i>Minois dryas</i>	50
<i>Thymelicus lineola</i>	47
<i>Erynnis tages</i>	35
<i>Brintesia circe</i>	29
<i>Pieris rapae</i>	28
<i>Polyommatus icarus</i>	28
<i>Plebejus argus</i>	27
<i>Pyrgus malvae/malvoides</i>	26

The three commonest species on the transect in the last five years make up almost 58% of all recorded specimens. All three belong to the Satyrinae subfamily and their larvae feed on different species of grasses (Poaceae). While most of the threatened species were seen only once or twice during the transect walks, the Scarce Large Blue (*P. teleius*), Marsh Fritillary (*E. aurinia*), and Nickerl's Fritillary (*M. aurelia*) were still reasonably common.

Discussion

There is no doubt that the Mlake military area is, or at least has been, one of the most remarkable hot spots of butterfly diversity not only in Slovenia, but also in Europe. Although information on diversity of comparable small size areas is lacking, the comparison can be drawn with transect monitoring scheme in Catalunya, where only three out of more than 100 transects have more than 100 species recorded (CBMS 2011). These transects are situated in the valleys of the western Pyrenees, where a mixture of alpine and mediterranean species facilitate such high diversity. One additional example is the Jelašnica Gorge in eastern Serbia, where 110 species were recorded along 2 km long stretch of the gorge (Đurić et al. 2010). The high diversity there is attributed to the surviving relict populations of thermophilous butterfly species in the microclimatically favourable conditions on southern exposed slopes and high level of habitat structuring. The latter is definitively true also for the Mlake where military activities have provided high level of structuring of habitat, exposition and vegetation coverage. The bare ground has an important role for thermoregulation for many butterfly species and is therefore an essential part of their habitat (Dennis 2010). Equally important for high butterfly diversity is also a gradient from wet unimproved grasslands to extremely dry stony grasslands on the slopes and presence of woodland edges. Such habitat diversity could be linked with larval host plant diversity, which is essential for the presence of many habitat or host plant specialist species.

The habitat diversity is well reflected in the presence of habitat specialist butterfly species. The humid grassland hosts species like the Scarce Large Blue (*P. teleius*), the Alcon Blue (*P. alcon*), the Marsh Fritillary (*E. aurinia*), the False Heath Fritillary (*M. diamina*), and the Large Copper (*Lycaena dispar*). The flower rich calcareous grassland, on the other hand, hosts species like the Marbled Skipper (*C. lavatherae*), the Eastern Baton Blue (*P. vicrama*), the Assmann's Fritillary (*Melitaea britomartis*), and the False Grayling (*Arethusana arethusae*). Other habitat specialists like the Chequered Blue (*Scolitantides orion*) and the Mountain Small White (*Pieris ergane*) were present on patchy overgrown man-made hills and along tracks. Most of the named species are considered threatened in Slovenia (Uradni list RS, No. 82/2002) due to their recent habitat loss.

When comparing the lists of species between the two periods, it is evident that the faunal composition has not changed much in such a short period of time, and that overall butterfly diversity did not decline, actually 3 more species were observed in the last period. As habitat loss due to overgrowing and urbanization of the area is over 50%, the discrepancy between the observed and expected biodiversity could only be explained by the change of survey methodology and almost doubled effort in the second time period. The transect method provides more systematic survey and greater chance of finding rare species, which can be achieved also by increasing the amount of field work (Schmitt et al. 2002). Out of 10 newly recorded species in the last period, six were observed only once, two on two occasions, and can therefore be considered rare species in the Mlake military area. The only species for which a genuine recent colonization is a plausible explanation is the Nettle-tree Butterfly (*Libythea celtis*), which has been regularly observed in last three years in the northern part of the area. However, this species is a known migrant with high fluctuations in densities. Its presence

could therefore be considered as temporary, even more so, as the larval host plant the Nettle Tree (*Celtis australis*) is not present at that site.

The losses, on the other hand, are much more indicative, as five out of seven species not recorded in the second time period are habitat specialists and are also included in the Red List of Threatened Species in Slovenia. Among species lost are the Marbled Skipper (*C. lavatherae*), the Assmann's Fritillary (*Melitaea britomartis*) and the Idas Blue (*Plebejus idas*), which were found on now rapidly overgrowing dry calcareous grasslands (Fig. 1). Also the two species from ruderal sites, the Chequered Blue (*Scolitantides orion*) and the Mountain Small White (*Pieris ergane*), have not been observed after the shooting range construction. These losses can thus be directly attributed to habitat loss and it is unlikely that they would be refound at this site. Surprisingly, none of the humid grassland specialists has disappeared, despite lowering the water table by an almost 1,5 metre deep ditch and reduction of the upstream water catchment by building the shooting range. The likely reason, a rather pessimistic one, is that the process of overgrowing is not as fast on the humid part as on dry calcareous grasslands, and the effects of it will be seen in the near future. The potential loss of the False Heath Fritillary (*M. diamina*), which was observed only in 2007, could be an indication of that process.

Even more worrying is the general decline both in species diversity (Fig. 3) and relative abundances (Fig. 4), as it indicates overall habitat degradation. As both variables are prone to seasonal variation due to climatic conditions, a longer time series would be needed to ascertain whether the decline is genuine, or only a short reaction to abrupt changes in the environment. The year 2007 could be considered as the closest to the previous conditions in the Mlake military area, as building of the shooting range has not yet been completed. The drastic decline in 2008, followed by stabilization in the next years, could thus be at least partially linked to habitat degradation. Although Mlake has at present retained the high species diversity of butterflies, we fear that its fauna and flora will become increasingly impoverished without proper management. Therefore we hope that recognition of the Mlake military area as one of the national conservation priorities would urge the authorities to revert the ongoing overgrowing and avoid any further activities that would enhance the lowering of the water table. This would then improve the chances of preserving this exceptionally high diversity for future generations.

Acknowledgements

The authors would like to thank the staff of the Center of Cartography of Fauna and Flora for their help in data collation and management of the database. Part of the research was funded by the Slovenian Research Agency (M1-0148).

Povzetek

Vipavska dolina je znana po izjemni vrstni pestrosti dnevnih metuljev in ima dolgo zgodovino favnističnih raziskav. Vojaško območje Mlake je prišlo pod drobnogled po osamosvojitvi Slovenije ob razgrnitvi prostorskega načrta graditve avtoceste čez Rebrnice, ki bi to območje v celoti povozilo. Že prve raziskave (Verovnik 2000) so razkrile izjemen potencial vrstne pestrosti dnevnih metuljev tega območja. Pri ohranjanju le te je imela prav vojska ključno vlogo, saj so se zaradi nedostopnosti ohranili v Vipavski dolini sicer že zelo redki mokrotni travniki, ki proti pobočjem prehajajo v suhe kraške travnike. Poleg tega so aktivnosti vojske (graditev nasipov, tankovskih ovir, obstreljevanje) poskrbele tudi za izjemno strukturiranost mikrohabitatov, ki je ključna za visoko pestrost rastlinskih in živalskih vrst.

Intenzivne favnistične raziskave dnevnih metuljev na Mlakah so potekale v dveh obdobjih: od 1998 do 2002 in od 2007 do 2011. V prvem obdobju je bilo opravljenih 26 obiskov območja, v drugem obdobju pa zaradi vzpostavitve transektnega monitoringa kar 43. Transektni monitoring je potekal šest do osemkrat letno na petih odsekih na tistem delu Mlak, ki je ostal bolj ali manj nedotaknjen med gradbenimi posegi. S transektnimi popisi smo dobili tudi kvantitativne podatke o pojavljanju vrst.

Gledano v celoti se pestrost in struktura vrst med obema obdobjema nista bistveno spremenili, število opaženih vrst se je celo povečalo za tri. To gre predvsem na račun transektne metode, kjer so obiski območja bolj enakomerno razporejeni v sezoni pojavljanja odraslih osebkov in večjega števila obiskov. Tako lahko odkrijemo večje število na območju redkih vrst in dejansko je večina na novo opaženih vrst bila najdena le enkrat ali dvakrat v petih letih. Med vrstami, ki jih v zadnjem obdobju nismo našli, pa je večina habitatnih specialistov, kar nakazuje izgubo habitata. V zadnjih petih letih je bilo na transektu opaziti upadanje vrstne pestrosti in številčnosti metuljev, kar je verjetno odsev splošne degradacije življenjskega prostora na tem območju. Vsekakor upamo, da bo predstavitev Mlak kot izjemne 'vroče točke' diverzitete metuljev pripomogla k bolj aktivnemu upravljanju s habitatni na tem območju in s tem k dolgoročnemu ohranjanju njenega naravovarstvenega pomena za Slovenijo.

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